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Final Report

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Pumping and Depressurizing of Insulation Materials
NASA/INSPIRE
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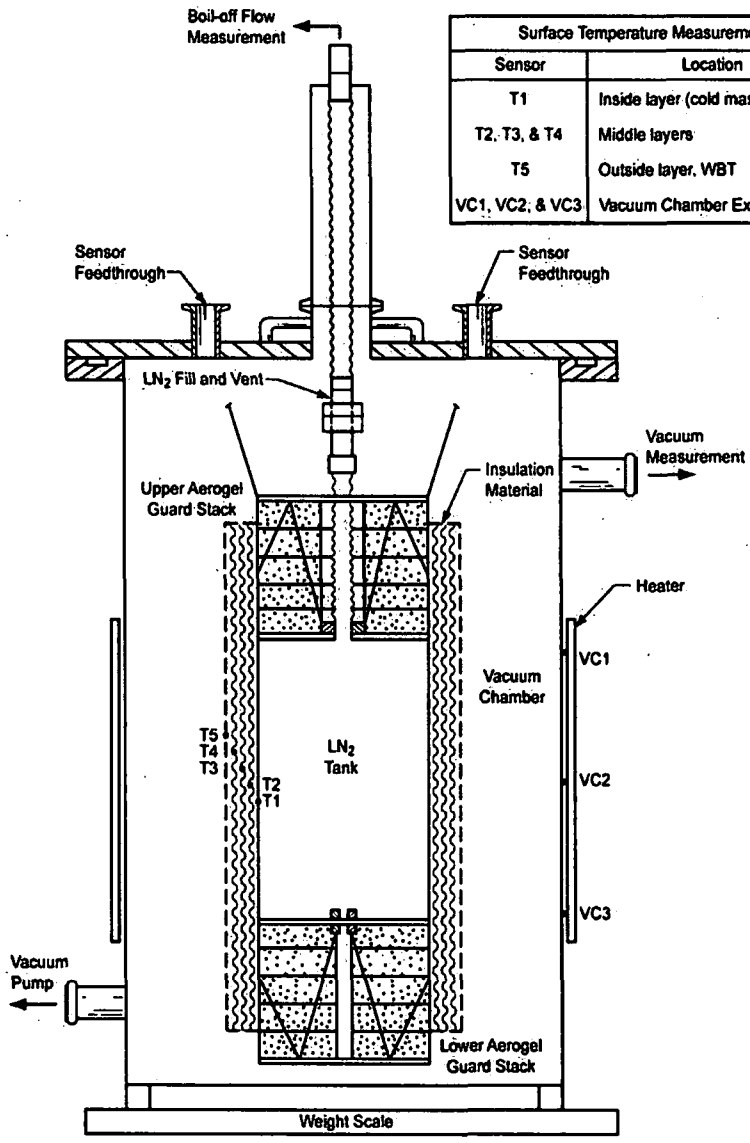
INTRODUCTION

The Fluids Testing and Technology Branch is a group that researches and tests efficient ways to use various Cryogenic Fluids, such as Liquid Nitrogen or Liquid Helium, in ground and space systems. Their main goal is to develop new technologies involving Cryogenic temperatures as well as making sure the existing technologies are understood. During my time here a lot of insulation testing has been done which is where insulation systems are tested for cryogenic systems that are in space for long durations.

EXPERIMENT

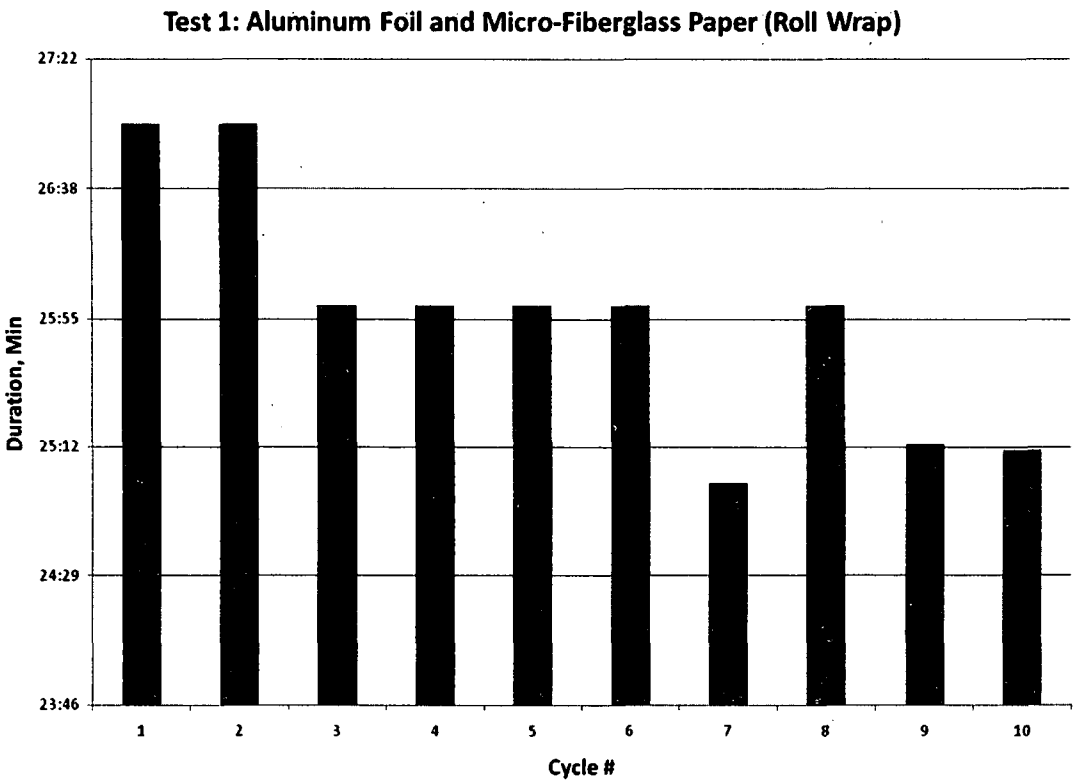
My project was on the pumping effects of repeated purging within Multilayered Insulation (MLI). To complete my project I used the Cryostat 3, a device that is used to test various MLI systems in Cryogenic Fluid conditions. The Cryostat 3 consists of a vacuum chamber where the purging and depressurization are performed. The Cryostat uses Baratrons to measure the pressure in the tank. The pressure is controlled by two valves, one controls Gaseous Nitrogen (GN2) inflow and the other controls the vacuum pump outflow. With the Cryostat 3 I used both vacuum and GN2 controls to determine which insulation had the best pumping performance. To complete this test I start at ambient (atmospheric) pressure, which is 760 Torr; so first the vacuum valve is opened to begin depressurization. When the pressure reaches 100 Torr time is recorded via a stopwatch until pressure reaches 1 Torr. This process is repeated for a total of 10 cycles.



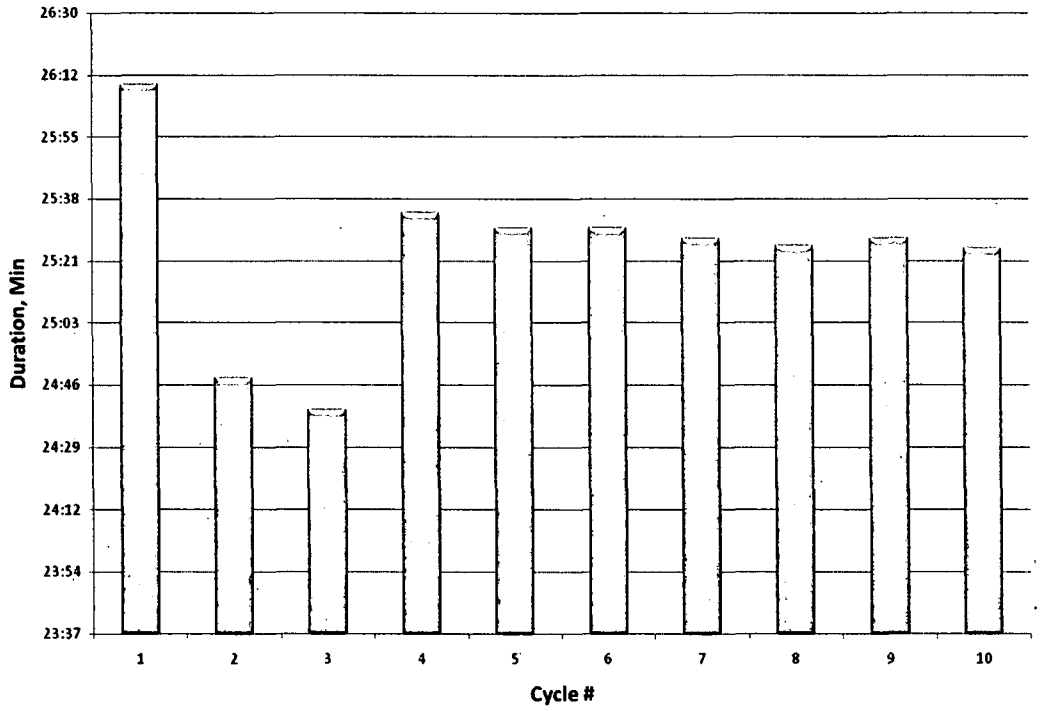
The purpose for this testing is that each time a purge and depressurization is performed impurities are being removed from the MLI material, or in other words the material is being degassed. The Fluids Testing and Technology Branch needs to know how many cycles it takes for MLI to be sufficiently purged, as to not harm insulation performance, so that they can perform tests as efficiently as possible. If this process is performed too many times the test can prove costly because of time wasted; furthermore, if the MLI has not undergone enough cycles the test can again be costly because the data received will be inaccurate and the test will have to be redone. The various insulation systems tested include Aluminum Foil and Micro-Fiberglass paper (roll wrap), Aluminum Foil and Micro-

Fiberglass paper (spiral wrap), Aluminized mylar and Micro-Fiberglass paper, and double Aluminized mylar and Dacron netting B2A where B2A is the size of the perforated holes. The results of this testing will feed into the lab's standard pumping and heating procedures that are used every time a new sample is put into a test chamber. Eventually, there are plans to include this data in an international cryogenic calorimeter test standard that would be used by test facilities across the world.

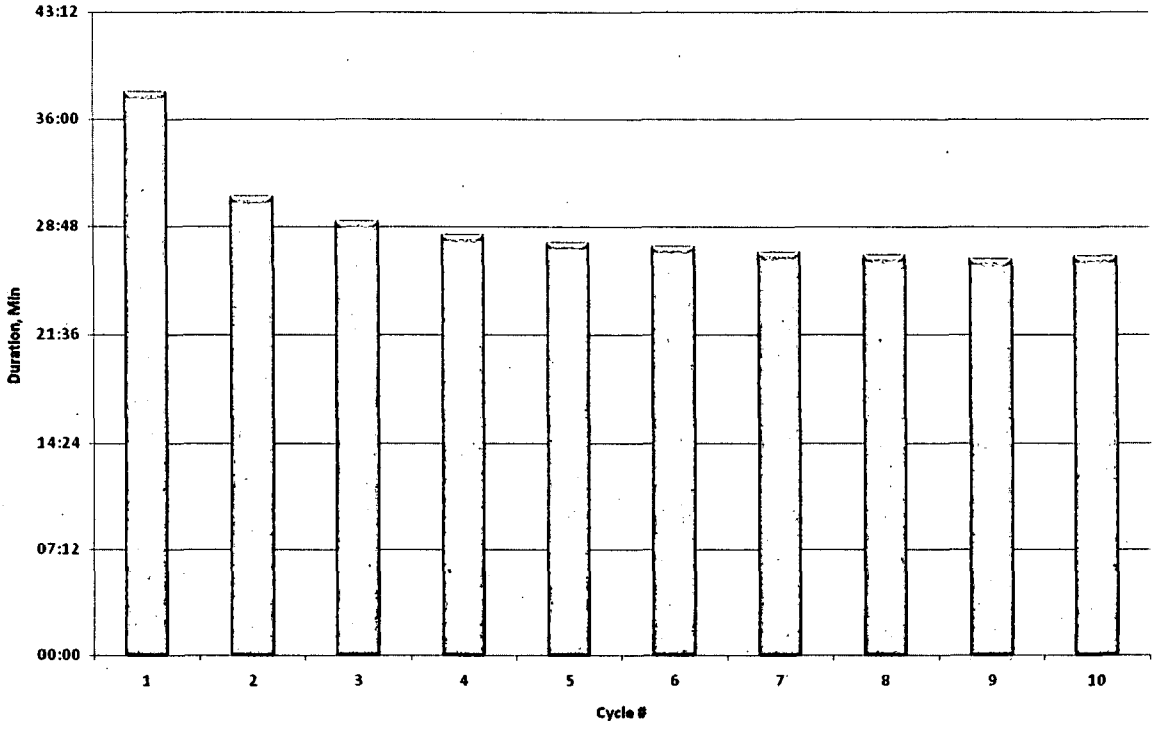
Although the Cryostat 3 was my main project for my internship at Kennedy Space Center this summer, I also had the opportunity to observe other projects and tests that my mentor had already been working on prior to my arrival. There is one project in particular that was very similar, as far as how the test was conducted, to my project and that was the Cryostat 100. The Cryostat 100 conducted similar testing as my project where a purge of GN2 and then depressurization were performed. At the conclusion of my project I used the data from the Cryostat 100 to compare my findings with the findings the Cryostat 100 produced when testing Aluminized mylar with Dacron netting.



Test 1: Aluminum Foil and Micro-Fiberglass Paper (Spiral Wrap)



Test 1: Aluminized Mylar and Micro-Fiberglass Paper



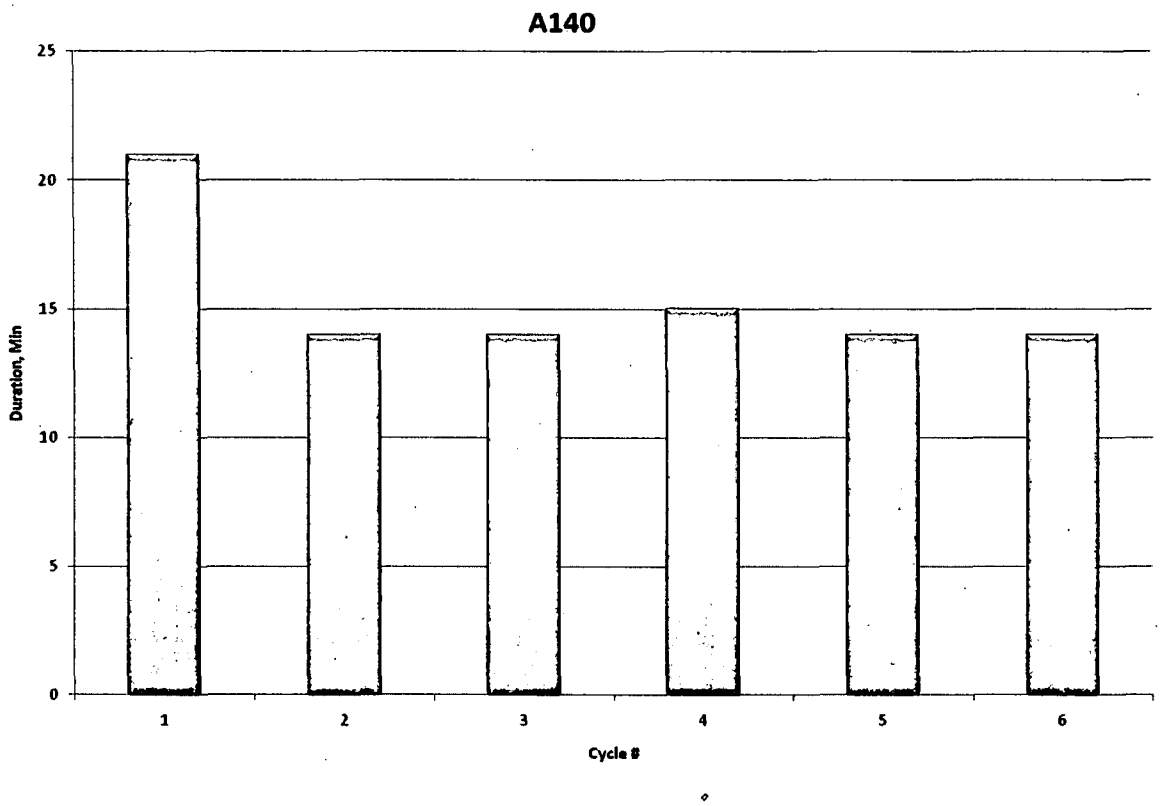
RESULTS

The results expected were for the durations of the depressurization of each MLI system to gradually decrease as I performed more cycles. The duration should decrease because each purge and depressurization degasses the MLI being tested. It is important to degas the MLI because when performing a boil off all impurities must be removed for the insulation to be efficient. As you can see from the three charts displayed the first cycle is always the longest in duration and as more cycles are performed the duration time decreases; however, it is not unusual for the duration time to suddenly increase as shown in chart one between cycles 7 and 8, this is just some scatter in the data which is common when conducting experiments. As previously stated I compared some of my data to the results of the Cryostat 100 which performed similar testing and here is a chart representing data gathered from the Cryostat 100's test of double Aluminized mylar with Dacron netting. Rather than 10 cycles only 6 cycles are displayed in the chart below. As you can see the results display a similar pattern where the first cycle has the longest duration and the following cycles show a decrease in duration time.

CONLCUSIONS

From the tests that were performed the appropriate conclusion can be made that the Aluminum Foil and the Micro-Fiberglass paper is a MLI system that offgasses slowly while the double Aluminized mylar with Dacron netting offgasses rapidly. Offgassing is when the MLI lets off vapors in the vacuum chamber as it depressurizes. The releasing of vapors off of the MLI material causes the vacuum to not pump as quickly as it could; therefore, if material offgasses slowly the cycle time then decreases slowly and if the material offgasses rapidly the cycle time decreases at a quicker pace as well. Through observing historical data gathered from previous tests I can conclude that it takes approximately 7 cycles

to purify Aluminum Foil with Micro-Fiberglass paper, 2 cycles to purify double Aluminized mylar with Dacron netting, and 4 cycles for the double Aluminized mylar and Micro-Fiberglass paper.



- Cryostat 100 data

EXPERIENCE

Outside of the project I worked on during my summer internship at KSC I was able to experience a variety of things. My experience was exciting from beginning to end. The very first day of my internship I was taken on a tour of the space center and I was able to see things that not too many people get to see in their life time. For example we were taken to the Orbiter Processing Facility (OPF) where I stood right under the shuttle Endeavor! I also got the opportunity to stand in the fourth largest building according to volume, the Vehicle Assembly Building (VAB), and see one of the Solid Rocket

Boosters inside! Furthermore, I have learned quite a bit of information due to working in the lab, attending meetings, and participating in my very first workshop. The workshop was called the Secondary Cryogenic Payload Testbed Workshop and this workshop brought Engineers and Specialists from various fields and companies together to brainstorm the best ways to complete their project, the Cryogenic Orbital Testbed (CRYOTE). I thought it was amazing how these people got together and threw ideas back and forth brainstorming and I found it quite intriguing. While working at KSC I was even able to travel to Tallahassee, Fl where I was a part of a NASA panel and spoke to children and teenagers participating in the Science Technology Engineering and Math (STEM) camps at Florida Agricultural and Mechanical University (FAMU). I am very thankful that I landed an internship in the Fluids Testing and Technology Branch because I am an interactive learner and working in the CTL and participating in all the hands-on activities really helped me grasp the procedures being done and learn the processes and purpose of each test I participated on better. Besides working and attending meetings I also attended some intern socials such as the BEST Barbeque and the Mentor and Intern Luncheon and these were some great networking and bonding activities that I thoroughly enjoyed. So I believe that I am leaving my KSC internship knowing so much more than I did coming in and I am glad that I was given the opportunity to spend two months of my summer at this great facility. I would like to thank Wesley Johnson, Johnny Nguyen, Wayne Heckle, James Fesmire, Hortense Burt, Priscilla Moore, Amber Wade, Darren Hutchins, and most of all my parents for making my experience at NASA great.